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US 5056413 A

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(54) **Vacuum brake booster**

(57) A vacuum brake booster 100 for a motor vehicle comprises a front vacuum chamber 16 and a rear, variable pressure chamber 18; an axially movable power piston 20 attached to diaphragm 14; a plunger 24 connected with a push rod 36; an annular vacuum valve seat 44 on the power piston; a first annular air valve seat 46 on the plunger; a first annular valve member 42 engageable with valve seats 44, 46; a second annular air valve seat 66 on the power piston; a second annular valve member 64 engageable with valve seat 66; and engaging means 78 mounted on the push rod or the plunger for engaging the second valve member. The arrangement being such that under extreme braking the second valve member 64 is moved away from its seat 68 by the engaging means to permit an increased volume of air to be supplied to the rear chamber via passage 70.

Fig.1.

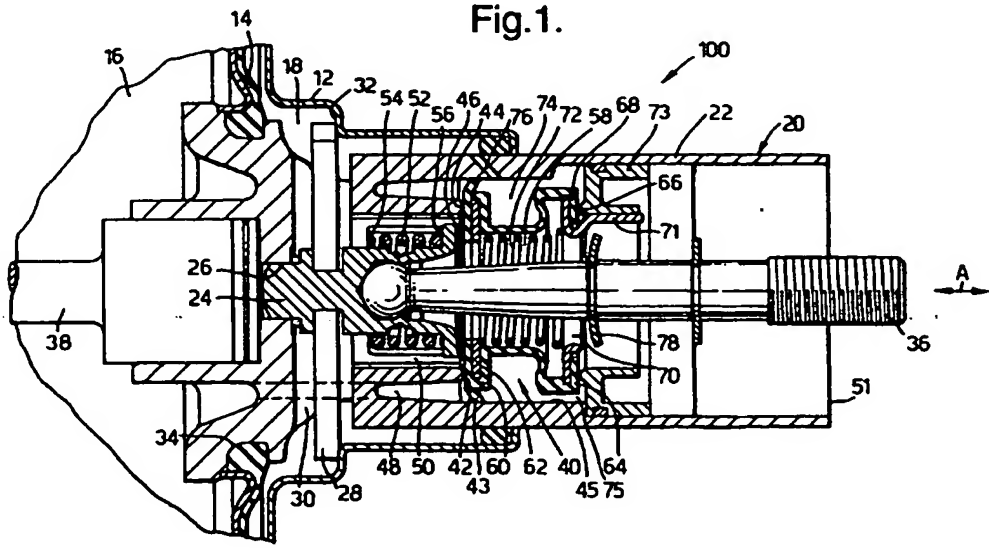

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Fig.1.

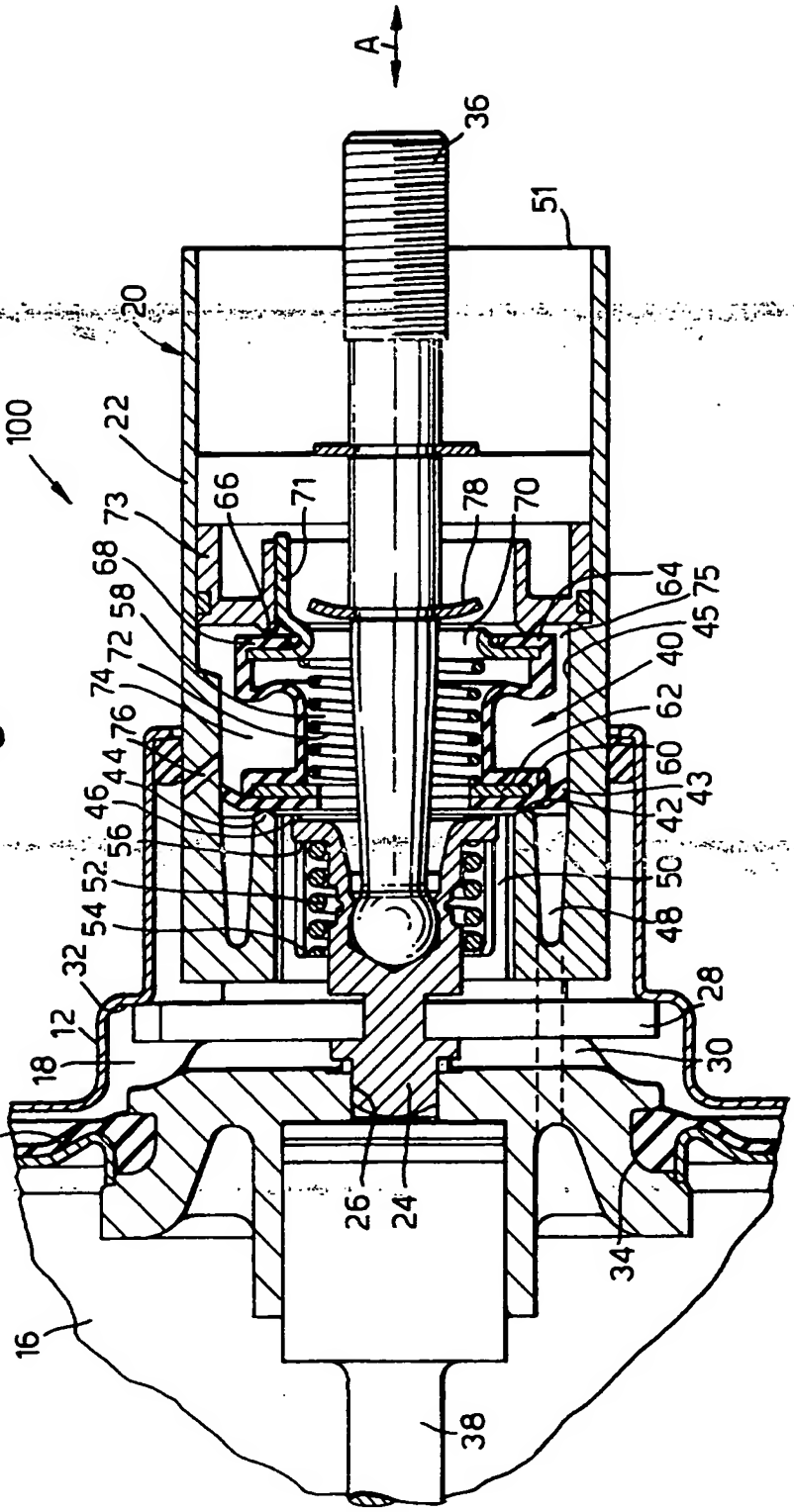
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Fig.2.

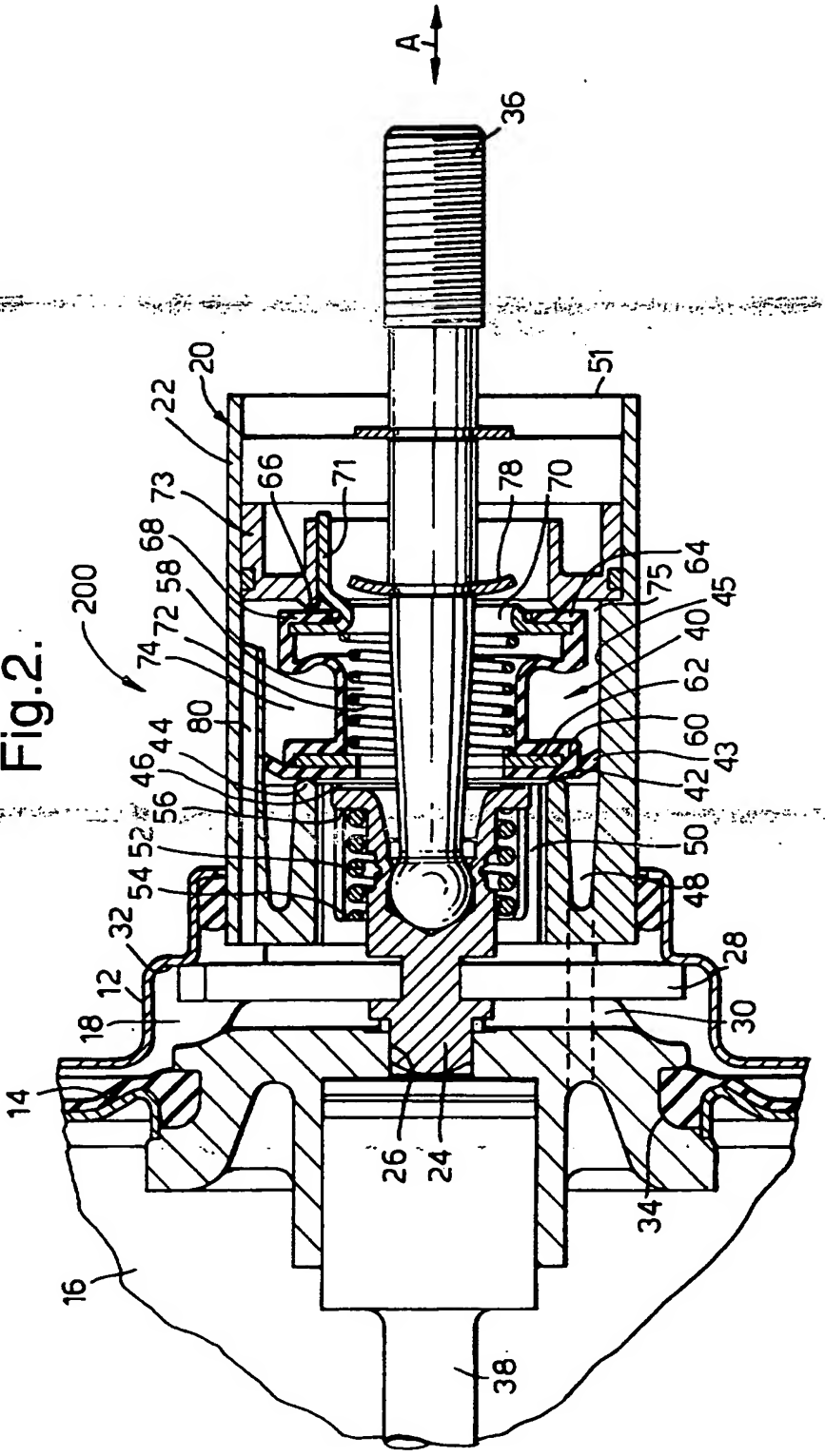
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Fig.3.

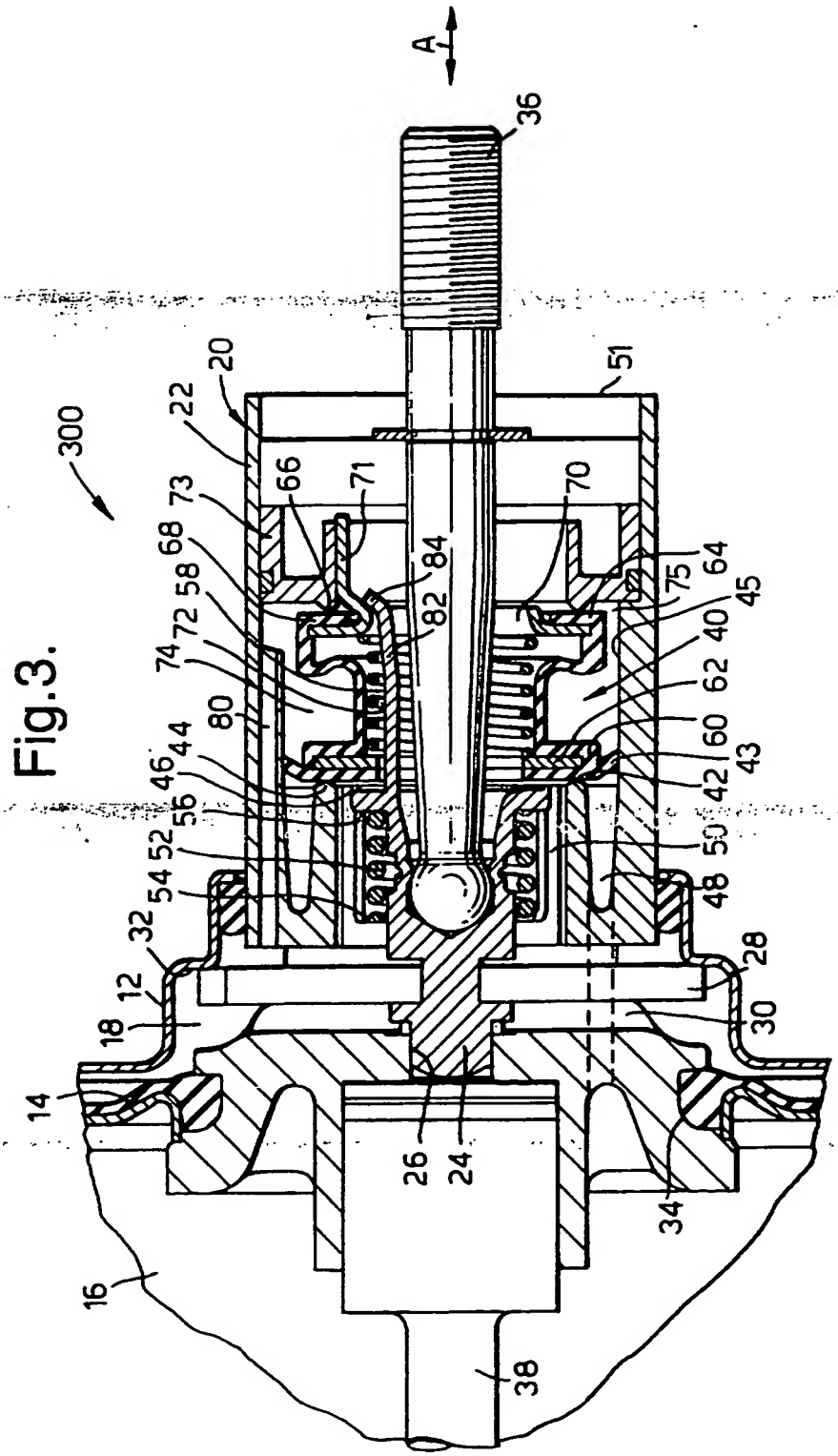
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Fig.4.

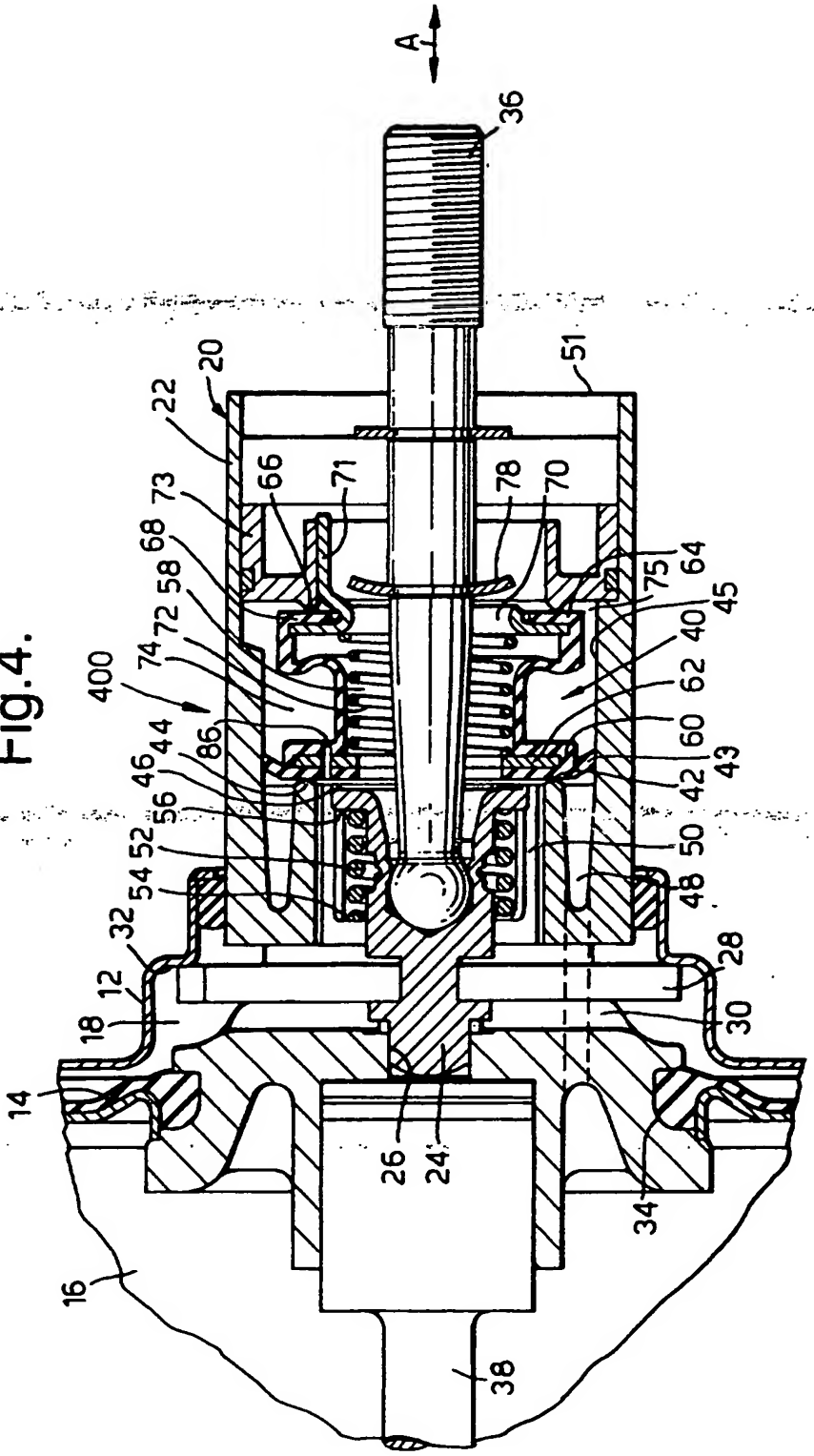
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Fig.5.

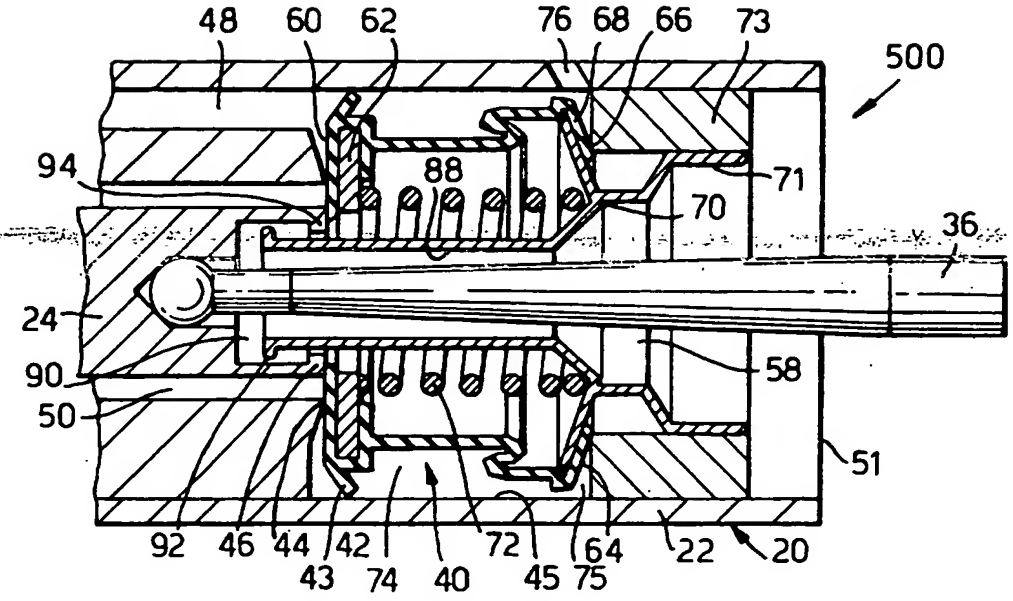
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Fig.6.

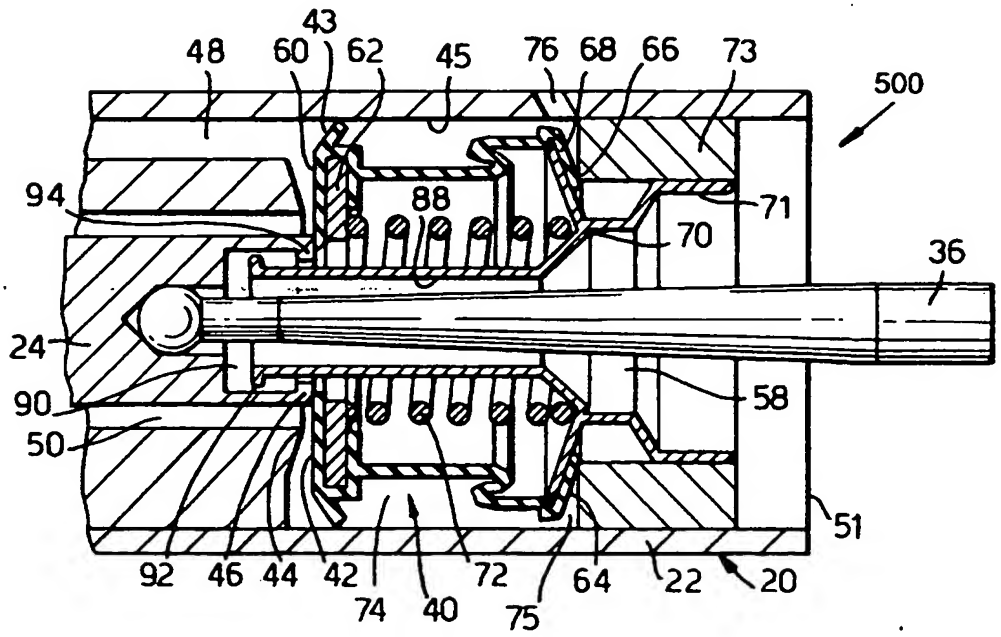
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Fig.7.

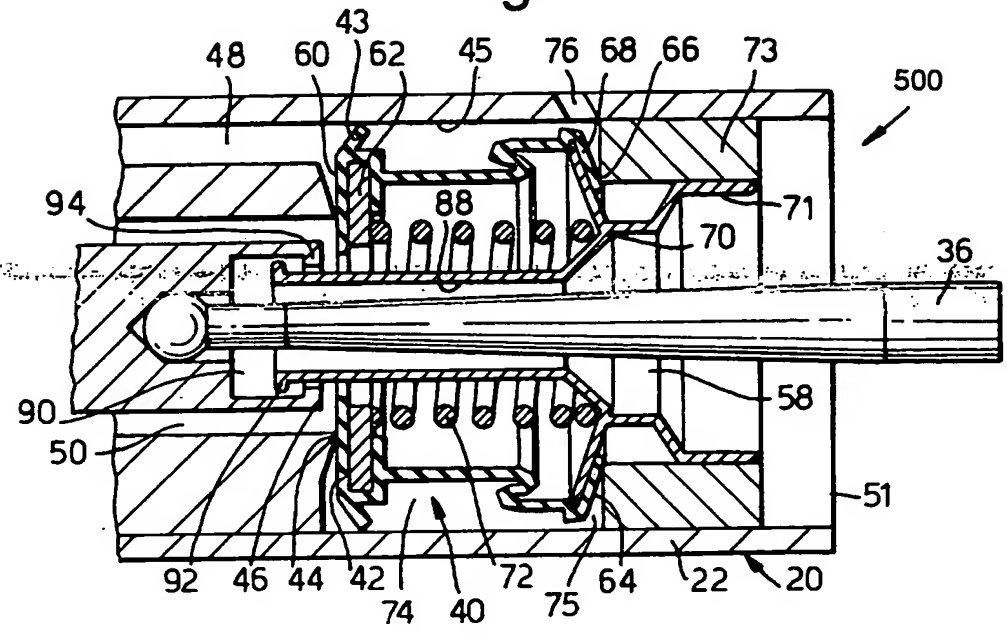
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Fig.8.

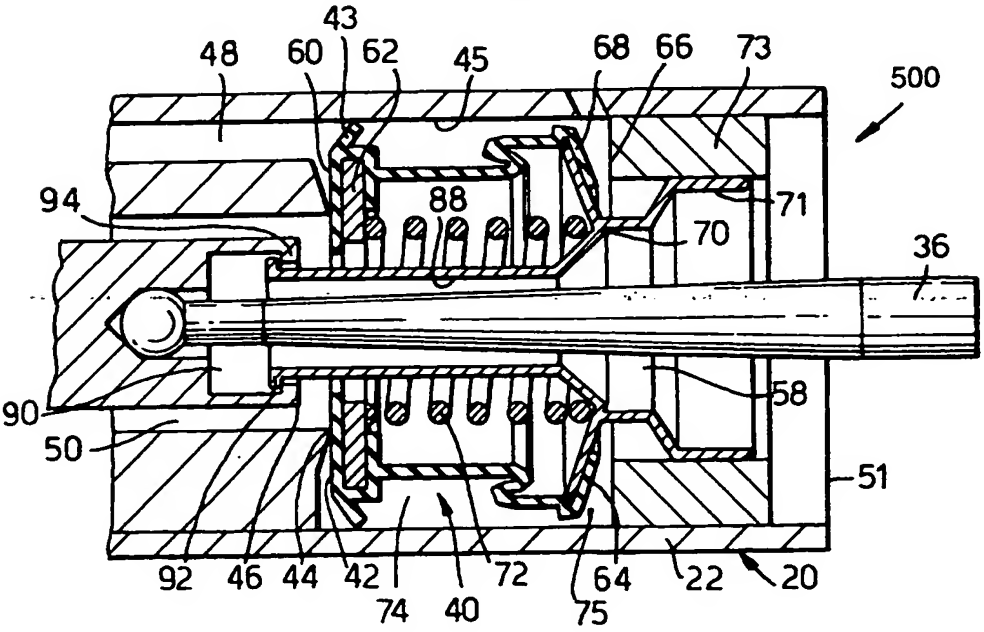
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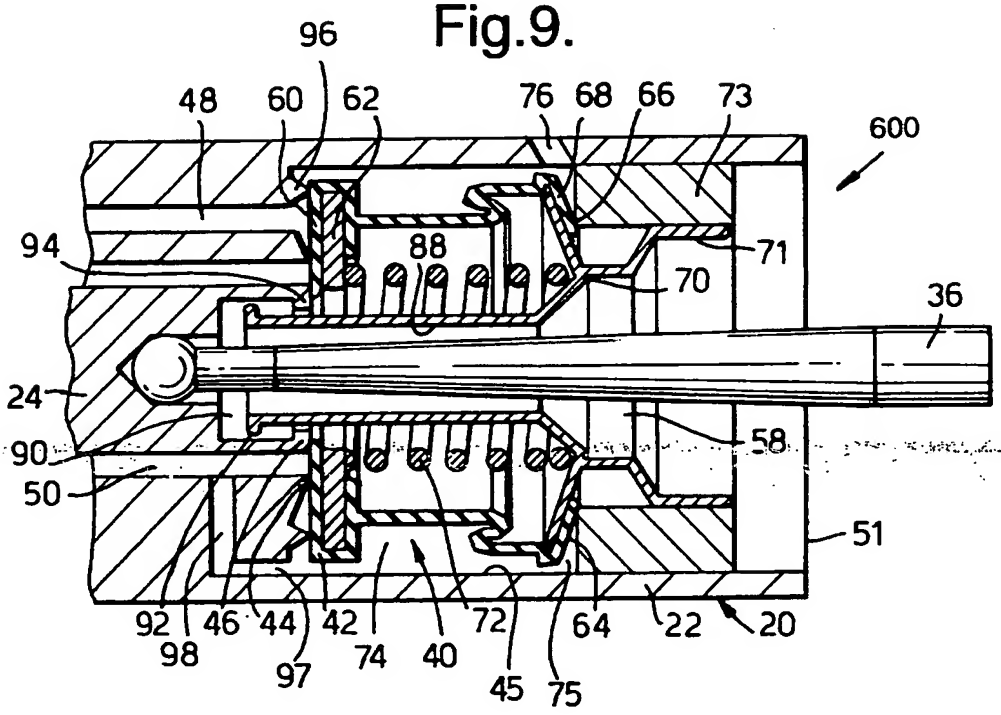
Fig.9.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H-197727

VACUUM BRAKE BOOSTER

Technical Field

The present invention relates to a vacuum brake booster or servo motor for the braking system of a motor vehicle. In particular, the present invention relates to the valving arrangement in such a brake booster.

Background of the Invention

Vacuum brake boosters for the braking system of motor vehicles typically comprise a housing; a diaphragm located within the housing to define a front chamber and a rear chamber; a power piston attached to the diaphragm and axially movable relative to the housing; a plunger located within the power piston, connected with a push rod, and capable of limited axial movement relative to the power piston; a vacuum valve on the power piston; and an air valve on the plunger. The front chamber is connected to a vacuum supply. The rear chamber is connectable with the front chamber or with air at atmospheric pressure dependent on the relative positions of the power piston and the plunger. The push rod is connectable with the vehicle brake pedal. The booster also has an output rod actuated by the power piston and/or the plunger for operating the vehicle brakes, typically by way of a master cylinder.

Summary of the Invention

It is an object of the present invention to provide an improved arrangement for the valving system of these known vacuum brake boosters.

To this end, a vacuum brake booster in accordance with the present invention for the braking system of a motor vehicle comprises a housing; a diaphragm located within the housing to define a front chamber and a rear chamber, the front chamber being connectable to a vacuum source; a power piston attached to the diaphragm and axially movable relative to the

housing; a plunger located within the power piston, connected with a push rod, and capable of limited axial movement relative to the power piston; an annular vacuum valve on the power piston; a first annular air valve on the plunger; a first annular valve seat engageable with the vacuum valve and with the first air valve and axially movable relative to the power piston; a second annular air valve on the power piston; a second annular valve seat engageable with the second air valve and axially movable relative to the power piston; the valves and valve seats being positioned inside a cylindrical portion of the power piston with the first valve seat rearward of the first air valve and the vacuum valve, with the second valve seat rearward of the first valve seat, and with the second air valve rearward of the second valve seat; engaging means mounted on the push rod or the plunger for engaging the second valve seat; a first passage in the power piston radially outward of the vacuum valve and connected with the front chamber; a second passage in the power piston radially inward of the vacuum valve and radially outward of the first air valve and connected with the rear chamber; a third passage radially inward of the first air valve and of the second air valve and connectable with air at or above atmospheric pressure; and a fourth passage at least a portion of which is radially outward of the second air valve and connectable with the rear chamber; the arrangement being such that, at a first axial position of the push rod relative to the power piston, the first air valve is in engagement with the first valve seat, the second air valve is in engagement with the second valve seat, the vacuum valve is disengaged from the first valve seat, and the front chamber is connected to the rear chamber by way of the first and second passages; at a second axial position of the push rod relative to the power piston, the first air valve is disengaged from the first valve seat, the second air valve is in engagement with the second valve seat, the vacuum valve is in engagement with the first valve seat, and the rear chamber is connected to air at atmospheric pressure by way of the second and third passages; and at a third axial position of the push rod relative to the power piston, the first air

valve is disengaged from the first valve seat, the second air valve is disengaged from the second valve seat due to engagement of the engaging means with the second valve seat, the vacuum valve is in engagement with the first valve seat, and the rear chamber is connected to air at atmospheric pressure by way of the second and third passages and by way of third and fourth passages.

This present invention provides a faster fill time for the rear chamber during extreme braking conditions, and hence faster brake application.

Brief Description of the Drawings

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a partial cross-sectional view of a first embodiment of vacuum brake booster in accordance with the present invention;

Figure 2 is a partial cross-sectional view of a second embodiment of vacuum brake booster in accordance with the present invention;

Figure 3 is a partial cross-sectional view of a third embodiment of vacuum brake booster in accordance with the present invention;

Figure 4 is a partial cross-sectional view of a fourth embodiment of vacuum brake booster in accordance with the present invention;

Figure 5 is a partial cross-sectional view of the valving arrangement of a fifth embodiment of vacuum brake booster in accordance with the present invention with the brake booster in an equilibrium position;

Figure 6 is a similar view to that of Figure 5 showing the vacuum brake booster in its 'rest' position;

Figure 7 is a similar view to that of Figure 5 showing the vacuum brake booster in its normal braking position;

Figure 8 is a similar view to that of Figure 5 showing the vacuum brake booster in its extreme braking position; and

Figure 9 is a partial cross-sectional view of the valving arrangement of a sixth embodiment of vacuum brake booster in accordance with the present invention with the brake booster in an equilibrium position.

Description of the Preferred Embodiment

Referring to Figure 1, the first embodiment of vacuum brake booster 100 (which is used in the braking system of a motor vehicle) includes a housing 12 with a diaphragm 14 positioned within the housing to define a front chamber 16 and a rear chamber 18. The front chamber 16 is connected to a vacuum source (not shown). A power piston 20 is positioned in the housing 12 and has a substantially cylindrical portion 22 which extends from the rear of the housing. A plunger 24 is mounted within an axial bore 26 in the power piston 20. The power piston 20 can move relative to the housing 12 in an axial direction A. The plunger 24 can move relative to the power piston 20 in the axial direction A. Such relative movements are restricted by a key member 28 which passes through a diagonally extending aperture 30 in the power piston 20, is engageable with an internal shoulder 32 on the housing 12, and which loosely engages the plunger 24. Other forms of interengagement may be used between the housing 12, power piston 20, and plunger 24. The internal edge 34 of the diaphragm 14 is secured to the power piston 20. A push rod 36 is secured in the plunger 24 and extends out from the rear of the housing 12. The push rod 36 is connectable with the brake pedal (not shown) in the motor vehicle. An output rod 38 extends out of the housing 12 in a forward direction and is connected with the power piston 20. The output rod 38 is connectable to a piston (not shown) in a master cylinder (not shown) of the braking system.

Associated with the power piston 20 and the plunger 24 is a valving arrangement 40 which either connects the rear chamber 18 with the

front chamber 16, or isolates the rear chamber, or connects the rear chamber with air at atmospheric pressure. The valving arrangement 40 is positioned within the cylindrical portion 22 of the power piston 20. The valving arrangement 40 comprises an annular valve seat 42 which is axially movable relative to the power piston 20 and directed towards the front of the brake booster 100; an annular vacuum valve 44 formed on, or mounted on, the power piston, directed towards the rear of the brake booster, and engageable with the valve seat; and an annular air valve 46 formed on, or mounted on, the plunger 24, directed towards the rear of the brake booster, and engageable with the valve seat. The valve seat 42 preferably comprises an annular elastomeric body 60 which is supported by an annular rigid member 62. Radially outwards of the vacuum valve 44 is a first passage 48 which extends in an axial direction through the power piston 20 and opens into the front chamber 16. Radially inwards of the vacuum valve 44 and radially outwards of the air valve 46 is a passage 50 which extends in an axial direction through the power piston 20 and opens into the rear chamber 18 by way of the diagonal aperture 30. Passage 50 and aperture 30 define a second passage. Radially inwards of the air valve 46 is a third passage 58 which receives air at atmospheric pressure through the open end 51 of the cylindrical portion 22. A spring 52 acting on opposed shoulders 54, 56 of the power piston 20 and the plunger 24 respectively biases the air valve 46 in a rearward direction into engagement with the valve seat 42. As explained in greater detail below in respect of the fifth embodiment (Figures 5 to 8), in the rest position the vacuum valve 44 is spaced from the valve seat 42 whereas the air valve 46 engages the valve seat, thereby connecting the rear chamber 18 to the vacuum in the front chamber 16 by way of passages 48, 50 and aperture 30. In the normal braking position, the air valve 46 is spaced from the valve seat 42 and the vacuum valve 44 is in engagement with the valve seat thereby connecting the rear chamber 18 to air at atmospheric pressure by way of passages 50, 58 and aperture 30.

The vacuum brake booster as thus far described, and its operation, is well known to those skilled in the art, and will not be described in greater detail.

In accordance with the present invention, the valving arrangement 40 further comprises a second annular valve seat 64 engageable by a second annular air valve 66. The second valve seat 64 is axially movable relative to the power piston 20 and directed towards the rear of the brake booster, and the second air valve 66 is secured to, or formed on, the power piston 20 and directed towards the front of the brake booster. The second valve seat 64 preferably comprises an annular elastomeric body 68 which is supported by an annular rigid member 70. The rigid member 70 preferably has axially extending arms 71 which are slidably supported on the member 73 defining the second air valve 66. The elastomeric body 68 of the second valve seat 64 is preferably integrally formed with the elastomeric body 60 of the first valve seat 42. A lip 43 is integrally formed on the elastomeric body 60 of the first valve seat 42 which sealably slidably engages the inner surface 45 of the cylindrical portion 22 of the power piston 20. The space between the integral elastomeric bodies 60, 68, the lip 43, the inner surface 45 of the cylindrical portion 22, and the second air valve 66 defines an intermediate air chamber 74. The second valve seat 64 and air valve 66 are positioned rearward of, and closer to, the open end 51 of the cylindrical portion 22 of the power piston 20 than, the first valve seat 42, vacuum valve 44 and first air valve 46. A spring 72 extends between both valve seats 42,64 to bias the valve seats away from one another in the axial direction. Radially inwards of the second air valve 66 is the air passage 58. Radially outwards of the second air valve 66 is a portion 75 of the intermediate air chamber 74. The intermediate air chamber 74 is connected with the rear chamber 18 by way of a radial aperture 76 in the power piston 20. The portion 75 of the intermediate chamber 74, the intermediate air chamber, and the radial aperture 76 define a fourth passage. Engaging means in the form of a ring 78

is secured to the push rod 36 rearward of the second valve seat 64. During extreme braking, in which the push rod 36 travels further than during normal braking, the ring 78 engages the second valve seat 64 to disengage the second air valve 66 from the second valve seat. As described in greater detail below, such an arrangement opens an additional passage for air at atmospheric pressure to reach the rear chamber 18 - in this case, by way of passage 58, intermediate chamber 74, and radial aperture 76.

In the second embodiment of vacuum brake booster 200 shown in Figure 2, like parts have been given the same reference numeral as those in Figure 1. Relative to the first embodiment, the radial aperture 76 in the power piston 20 is replace by an axially extending passage 80 in the power piston 20 which connects the intermediate air chamber 74 with the rear chamber 18. Other features of the second embodiment of brake booster 200, and its operation, are substantially the same as the first embodiment of vacuum brake booster 100 shown in Figure 1.

In the third embodiment of vacuum brake booster 300 shown in Figure 3, like parts have been given the same reference numeral as those in Figure 2. Relative to the second embodiment, the ring 78 secured to the push rod 36 is omitted. In this case, the plunger 24 has a number of integral, rearwardly extending, arms 82 having outwardly directed lips 84 at their free end positioned rearward of the second valve seat 64. During extreme braking conditions, the lips 84 engage the second valve seat 64 to disengage the second valve seat from the second air valve 66. Other features of the third embodiment of brake booster 300, and its operation, are substantially the same as the first embodiment of vacuum brake booster 100 shown in Figure 1.

In the fourth embodiment of vacuum brake booster 400 shown in Figure 4, like parts have been given the same reference numeral as those in Figure 1. Relative to the first embodiment, the radial aperture 76 in the power piston 20 is replace by an axially extending passage 86 through the first

valve seat 42 between the vacuum valve 44 and the first air valve 46 which connects the intermediate air chamber 74 with the rear chamber 18 by way of the air passage 50 and the aperture 30. Other features of the fourth embodiment of brake booster 400, and its operation, are substantially the same as the first embodiment of vacuum brake booster 100 shown in Figure 1.

In the fifth embodiment of vacuum brake booster 500 shown in Figures 5 to 8, like parts have been given the same reference numeral as those in Figure 1. Relative to the first embodiment, the ring 78 on the push rod 36 is omitted. In this embodiment, the second valve seat 64 has a number of forwardly extending legs 88 (which are preferably integral with the rigid support member 62) which extend into a chamber 90 in the plunger 24. The free ends of the legs 88 have outwardly directed arms 92, and the open end of the chamber 90 has an inwardly directed rim 94. Except during extreme braking conditions (as described below), the arms 92 are spaced from the rim 94. Other features of the fifth embodiment of brake booster 500 are substantially the same as the first embodiment of vacuum brake booster 100 shown in Figure 1.

Each of Figures 5 to 8 show the status of the valving arrangement 40 of the brake booster 500 at various stages of operation thereof. The first to fourth embodiments described above, and the sixth embodiment described below, operate in a substantially identical manner.

Figure 5 shows the valving arrangement 40 (and hence the brake booster) in an equilibrium state with both the vacuum valve 44 and the first air valve 46 engaging the first valve seat 42, and the second air valve 66 engaging the second valve seat 64. In this state, which occurs at rest, or when maintaining constant braking, the rear chamber 18 is isolated from both the front chamber 16 and from air at atmospheric pressure.

Figure 6 shows the valving arrangement 40 (and hence the brake booster) in its 'rest' state (when the brake booster returns to its rest

position after braking has occurred, or when the front chamber 16 is not under vacuum) with the push rod 36 in a first axial position relative to the power piston 20. In this position, the push rod 36 and the plunger 24 have moved back to their rest position which, due to the engagement of the first air valve 46 with the first valve seat 42, disengages the first valve seat from the vacuum valve 44. The second air valve 66 remains in engagement with the second valve seat 64. In this state, the rear chamber 18 is connected to the front chamber 16 by way of passages 48 and 50, and hence both chambers are under vacuum.

Figure 7 shows the valving arrangement 40 (and hence the brake booster) in a normal braking position with the push rod 36 in a second axial position relative to the power piston 20. In this position, the push rod 36 has moved towards the front of the brake booster (due to depression of the brake pedal by the vehicle operator) relative to the power piston 20. Such movement causes the plunger 24 to move in the same direction relative to the power piston 20. This relative movement brings the first valve seat 42 into engagement with the vacuum valve 44 and disengages the first air valve 46 from the first valve seat 42. The second air valve 66 remains in engagement with the second valve seat 64. In this state, the vacuum passage 48 is closed, and the rear chamber 18 is opened to air at atmospheric pressure by way of passages 50 and 58.

Figure 8 shows the valving arrangement 40 (and hence the brake booster) in an extreme braking position, for example, when the vehicle operator applies the brakes quickly and with extreme force, with the push rod 36 in a third axial position relative to the power piston 20. In this position, the push rod 36 has moved further (relative to the Figure 7 position) towards the front of the brake booster (due to the depression of the brake pedal by the vehicle operator) relative to the power piston 20. Such movement again causes the plunger 24 to move in the same direction relative to the power piston 20. This relative movement brings the first valve seat 42 into

engagement with the vacuum valve 44 and disengages the first air valve 46 from the first valve seat 42. However, because of the increased movement of the push rod 36 and the plunger 24, the rim 94 on the plunger engages the arms 92 on the legs 88 attached to the second valve seat 64 to disengage the second valve seat from the second air valve 66. In this state, the vacuum passage 48 is closed, and the rear chamber 18 is opened to air at atmospheric pressure by way of passages 50 and 58 and by way of passage 58, intermediate air chamber 74 and aperture 76. Such an arrangement reduces the fill time of the rear chamber 18 and ensures a faster application of the vehicle brakes during such extreme braking. In respect of the embodiments of Figures 1, 2, and 4, disengagement of the second valve seat 64 from the second air valve 66 occurs when the ring 76 on the push rod 36 engages the second valve seat. In respect of the embodiment of Figure 3, disengagement of the second valve seat 64 from the second air valve 66 occurs when the arms 84 of the legs 82 attached to the plunger 24 engage the second valve seat.

In the sixth embodiment of vacuum brake booster 600 shown in Figure 9, like parts have been given the same reference numeral as those in Figures 5 to 8. Relative to the fifth embodiment, the lip 43 on the elastomeric body 60 is omitted. In this embodiment, the first valve seat 42 has a larger diameter (compared to the fifth embodiment) and is engageable with an annular valve 96 mounted on the cylindrical portion 22 of the power piston 20 and positioned radially outward of the vacuum valve 44. The valve 96 and first valve seat 42 replace the function of the lip 43 in the fifth embodiment. The intermediate air chamber 74 is connected with the second passage 50 by way of an axially extending passage 97 which is radially outwards of the first valve seat 42, and a radially extending passage 98, the passages being formed in the power piston 20.

With the arrangements described above, during extreme braking conditions, an extra air passage to the rear chamber 18 is opened.

Such an arrangement reduces the fill time for the rear chamber 18 and thereby provides more rapid engagement of the vehicle brakes. This invention has particular application where the maximum diameter of the housing 12 of the brake booster 100-600 is increased relative to the maximum diameter of power piston 20.

Variations may be made to the embodiments described above. For example, the lip 43 of the embodiments shown in Figures 1 to 8 may be formed integrally with the elastomeric body 68 of the second valve seat 64. The third passage 58 may be connected to air at a pressure above atmospheric pressure. Either the first valve seat 42, or the second valve seat 64, or both, may be independently activated by electrical means, such as a solenoid valve.

Claims

1. A vacuum brake booster for the braking system of a motor vehicle comprising a housing; a diaphragm located within the housing to define a front chamber and a rear chamber, the front chamber being connectable to a vacuum source; a power piston attached to the diaphragm and axially movable relative to the housing; a plunger located within the power piston, connected with a push rod, and capable of limited axial movement relative to the power piston; an annular vacuum valve on the power piston; a first annular air valve on the plunger; a first annular valve seat engageable with the vacuum valve and with the first air valve and axially movable relative to the power piston; a second annular air valve on the power piston; a second annular valve seat engageable with the second air valve and axially movable relative to the power piston; the valves and valve seats being positioned inside a cylindrical portion of the power piston with the first valve seat rearward of the first air valve and the vacuum valve, with the second valve seat rearward of the first valve seat, and with the second air valve rearward of the second valve seat; engaging means mounted on the push rod or the plunger for engaging the second valve seat; a first passage in the power piston radially outward of the vacuum valve and connected with the front chamber; a second passage in the power piston radially inward of the vacuum valve and radially outward of the first air valve and connected with the rear chamber; a third passage radially inward of the first air valve and of the second air valve and connectable with air at or above atmospheric pressure; and a fourth passage at least a portion of which is radially outward of the second air valve and connectable with the rear chamber; the arrangement being such that, at a first axial position of the push rod relative to the power piston, the first air valve is in engagement with the first valve seat, the second air valve is in engagement with the second valve seat, the vacuum valve is disengaged from the first valve seat, and the front chamber is connected to the rear chamber by way of the first and second passages; at a second axial position of the push rod relative to the power piston, the first air valve is disengaged from the first

valve seat, the second air valve is in engagement with the second valve seat, the vacuum valve is in engagement with the first valve seat, and the rear chamber is connected to air at atmospheric pressure by way of the second and third passages; and at a third axial position of the push rod relative to the power piston, the first air valve is disengaged from the first valve seat, the second air valve is disengaged from the second valve seat due to engagement of the engaging means with the second valve seat, the vacuum valve is in engagement with the first valve seat, and the rear chamber is connected to air at atmospheric pressure by way of the second and third passages and by way of third and fourth passages.

2. A vacuum brake booster as claimed in Claim 1, wherein the first valve seat comprises an elastomeric body, wherein the second valve seat comprises an elastomeric body, and wherein the elastomeric bodies are integrally connected.

3. A vacuum brake booster as claimed in Claim 2, wherein the integral elastomeric bodies in conjunction with the cylindrical portion of the power piston define an intermediate air chamber which defines a part of the fourth passage.

4. A vacuum brake booster as claimed in any one of Claims 1 to 3, wherein the engaging means comprises a ring which is secured to the push rod in a position rearward of the second valve seat.

5. A vacuum brake booster as claimed in any one of Claims 1 to 3, wherein the engaging means comprises axially extending legs which are connected to the plunger and which have outwardly directed arms positioned rearward of the second valve seat which engage the second valve seat in the third axial position of the push rod.

6. A vacuum brake booster as claimed in any one of Claims 1 to 3, wherein the engaging means comprises an inwardly directed rim on the plunger which can engage outwardly directed arms on axially extending legs connected to the second valve seat in the third axial position of the push rod, the rim being positioned rearward of the arms.

7. A vacuum brake booster as claimed in any one of Claims 1 to 6, wherein the fourth passage includes an axially extending passage in the power piston.

8. A vacuum brake booster as claimed in any one of Claims 1 to 6, wherein the fourth passage includes a radially extending passage in the power piston.

9. A vacuum brake booster as claimed in any one of Claims 1 to 6, wherein the fourth passage includes a passage through the first valve seat which opens directly into the second passage.

10. A vacuum brake booster substantially as herein described with reference to, and as shown in, the accompanying drawings.